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AEDC-TR-71-207

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SEPARATION CHARACTERISTICS AND AERODYNAMIC LOADS DATA FOR THE MK-82GP, BLU-27, AND 450-GAL FUEL TANK IN THE VICINITY OF THE A-10A AIRCRAFT AT SUBSONIC SPEEDS

R. W. Butler

ARO, Inc.

October 1971

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NOTICES

SEPARATION CHARACTERISTICS AND AERODYNAMIC LOADS DATA FOR THE MK-82GP, BLU-27, AND 450-GAL FUEL TANK IN THE VICINITY OF THE A-10A AIRCRAFT AT SUBSONIC SPEEDS

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FOREWORD

The work reported herein was sponsored by the Aeronautical Systems Division (ASD), Air Force Systems Command (AFSC), for the Fairchild Hiller Corporation under Program Element 64211, Task 02B.

The test results presented were obtained by ARO, Inc. (a subsidiary of Sverdrup & Parcel and Associates, Inc.), contract operator of the Arnold Engineering Development Center (AEDC), AFSC, Arnold Air Force Station, Tennessee, under Contract F40600-72-C-0003. The test was conducted from June 15 through 22, 1971, under ARO Project No. PC0145. The manuscript was submitted for publication on August 11, 1971.

This technical report has been reviewed and is approved.

George F. Garey	Joseph R. Henry
Lt Colonel, USAF	Colonel, USAF
AF Representative, PWT	Director of Test
Directorate of Test	

ABSTRACT

Tests were conducted in the Aerodynamic Wind Tunnel (4T) to obtain store separation data and aerodynamic loads data on the MK-82GP, BLU-27, and 450-gal fuel tank in the flow field of the A-10A aircraft. Data were obtained at Mach numbers of 0.35 and 0.60 at a simulated altitude of 5000 ft. Free-stream force and moment data were also obtained for each store at Mach numbers of 0.35, 0.50, and 0.60. This report contains a description of the test and the recorded data, and presents an index of data obtained.

CONTENTS

NOMENCLATURE

BL	Aircraft buttock line from plane of symmetry, in., model scale
b	Store reference width, ft, full scale
C_A	Store axial-force coefficient, axial force/$q_\infty S$
C_{ℓ_p}	Store roll-damping derivative, $dC_\ell/d(pb/2V_\infty)$
C_m	Store pitching-moment coefficient, referenced to the store cg, pitching moment/$q_\infty S\bar{c}$
C_{m_q}	Store pitch-damping derivative, $dC_m/d(q\bar{c}/2V_\infty)$
C_n	Store yawing-moment coefficient, referenced to the store cg, yawing moment/$q_\infty Sb$
C_{n_r}	Store yaw-damping derivative, $dC_n/d(rb/2V_\infty)$
$\bar{c}$	Store reference length, ft, full scale
cg	Center of gravity
FS	Aircraft fuselage station, in., model scale
JRP	Aircraft jig reference plane
I_{xx}	Full-scale moment of inertia about the store X_B axis, slug-ft^2
I_{yy}	Full-scale moment of inertia about the store Y_B axis, slug-ft^2
I_{zz}	Full-scale moment of inertia about the store Z_B axis, slug-ft^2
M_∞	Free-stream Mach number
$\overline{m}$	Full-scale store mass, slugs
p	Store angular velocity about the X_B axis, radians/sec
q	Store angular velocity about the Y_B axis, radians/sec
q_i	Store initial angular velocity about the Y_B axis, radians/sec
q_∞	Free-stream dynamic pressure, psf
r	Store angular velocity about the Z_B axis, radians/sec

S	Store reference area, ft^2, full scale
t	Real trajectory time from initiation of trajectory, sec
V_∞	Free-stream velocity, ft/sec
WL	Aircraft waterline from reference horizontal plane, in., model scale
w_i	Initial velocity of the full-scale store in the positive Z_B direction relative to the origin of the flight-axis system, ft/sec
ΔX	Uncertainty in separation distance of the store cg parallel to the flight axis system X_F direction, ft, full scale measured from the prelaunch position
X_{cg}	Full-scale cg location, ft from nose of store
ΔY	Uncertainty in separation distance of the store cg parallel to the flight axis system Y_F direction, ft, full scale measured from the prelaunch position
Z_i	Full-scale distances from the carry position on the pylon to the trajectory starting position measured in the flight axis system Z_F direction
ΔZ	Uncertainty in separation distance of the store cg parallel to the flight-axis system Z_F direction, ft, full scale measured from the prelaunch position
α	Parent-aircraft model angle of attack relative to the free-stream velocity vector, deg
$\overline{\theta}$	Simulated parent-aircraft climb angle (angle between the flight direction and the earth horizontal, deg, positive for increasing altitude)
$\Delta\theta$	Uncertainty in the angle between the store longitudinal axis and its projection in the X_F - Y_F plane, positive when store nose is raised as seen by pilot, deg
$\Delta\psi$	Uncertainty in the angle between the projection of the store longitudinal axis in the X_F - Y_F plane and the X_F axis, positive when the store nose is to the right as seen by the pilot, deg

FLIGHT-AXIS SYSTEM COORDINATES

Directions

X_F	Parallel to the free-stream wind vector, positive direction is forward as seen by the pilot
Y_F	Perpendicular to the X_F and Z_F directions, positive direction is to the right as seen by the pilot

Z_F In the aircraft plane of symmetry, perpendicular to the free-stream wind vector, positive direction is downward

The flight-axis system origin is coincident with the aircraft cg and remains fixed with respect to the parent aircraft during store separation. The X_F, Y_F, and Z_F coordinate axes do not rotate with respect to the initial flight direction and attitude.

STORE BODY-AXIS SYSTEM COORDINATES

Directions

X_B Parallel to the store longitudinal axis, positive direction is upstream in the prelaunch position

Y_B Perpendicular to the store longitudinal axis, and parallel to the flight-axis system X_F - Y_F plane when the store is at zero roll angle, positive direction is to the right looking upstream when the store is at zero yaw and roll angles

Z_B Perpendicular to both the X_B and Y_B axes, positive direction is downward as seen by the pilot when the store is at zero pitch and roll angles

The store body-axis system origin is coincident with the store cg and moves with the store during separation from the parent airplane. The X_B, Y_B, and Z_B coordinate axes rotate with the store in pitch, yaw, and roll so that mass moments of inertia about the three axes are not time-varying quantities.

SECTION I
INTRODUCTION

In the development of a new fighter aircraft, consideration must be given to the separation characteristics of external stores launched from the aircraft. This is especially true for the Fairchild Hiller A-10A aircraft with ordnance carried on 10 externally mounted wing pylons.

In an effort to obtain sufficient aerodynamic data to substantiate the safe separation characteristics of three test stores from the A-10A aircraft and to obtain aerodynamic loads data in selected regions surrounding the wing pylons, an experimental study was conducted in the Aerodynamic Wind Tunnel (4T) of the Propulsion Wind Tunnel Facility (PWT).

The test was conducted by obtaining captive trajectory store separation trajectories and aerodynamic load measurements with models of the MK-82GP, BLU-27, and 450-gal fuel tank in the vicinity of the A-10A aircraft. Free-stream force and moment data were also obtained on each store model with the parent aircraft model removed from the tunnel in order to assess the influence of the aircraft on the store loads.

SECTION II
APPARATUS

2.1 TEST FACILITY

Tunnel 4T is a closed-loop, continuous flow, variable density tunnel in which the Mach number can be varied from 0.2 to 1.3. At all Mach numbers, the stagnation pressure can be varied from 200 to 3400 psfa. The test section is 4 ft square and 12.5 ft long with perforated, variable porosity (0.5- to 10-percent open) walls. It is completely enclosed in a plenum chamber from which the air can be evacuated, allowing part of the tunnel airflow to be removed through the perforated walls of the test section.

For store separation testing, two separate and independent support systems are used to support the models. The parent aircraft model is inverted in the test section and supported by an offset sting attached to the main pitch sector. The store model is supported by the captive trajectory support (CTS) which extends down from the tunnel top wall and provides store movement (six degrees of freedom) independent of the parent-aircraft model. An isometric drawing of a typical store separation installation is shown in Fig. 1, Appendix I.

Also shown in Fig. 1 is a block diagram of the computer control loop used during captive trajectory testing. The analog system and the digital computer work as an integrated unit and, utilizing required input information, control the store movement during a trajectory. Store positioning is accomplished by use of six individual d-c electric motors. Maximum translational travel of the CTS is ±15 in. from the tunnel centerline in the lateral and vertical directions and 36 in. in the axial direction. Maximum angular displacements are ±45 deg in pitch and yaw and ±360 deg in roll. A more complete description of the test facility can be found in the Test Facilities Handbook.[1] A schematic diagram showing the test section details and the location of the models in the tunnel is shown in Fig. 2.

Aerodynamic load surveys were obtained using the same installation as for trajectory simulation. The CTS positions were controlled by the digital computer using a preprogrammed position matrix.

2.2 TEST ARTICLES

Models used during this test consisted of 0.05-scale models of the A-10A aircraft, MK-82GP bomb, BLU-27 finned bomb, and 450-gal fuel tank. A sketch showing basic dimensions of the A-10A aircraft is presented in Fig. 3. The horizontal and vertical stabilizers were removed to alleviate sting interference when the store pitched nose down. The basic A-10A model consisted of the wings (W), the fuselage body (B), the two engine nacelles (N), the two main landing gear pods (G_p), and ten pylons (P). The basic configuration has all control surfaces at neutral and is designated as $WBNG_pP$. Figure 4 shows a typical tunnel installation photograph of this basic configuration with the addition of stores designated $WBNG_pP_4S$. A sketch showing flap and deceleron positioning in the region of each wing pylon along with dimensions of each pylon is shown in Fig. 5. A second parent aircraft configuration is the control-deflected (C) version of the basic model. For the control-deflected model, the trailing-edge flaps were deflected down 30 deg and the decelerons were deflected fully to 65 deg. With asymmetrical aileron deflection of right wing aileron down 15 deg and left wing aileron up 20 deg, the configuration shown in Fig. 5 by dashed lines results. This configuration is designated $WBNG_pPC$. A photograph showing the A-10A model with control surfaces deflected is shown in Fig. 6. The notches shown in the right wing deceleron and flaps were added to relieve a sting interference problem when launching from pylons 1, 3, and 4. The function of the notches may be more readily seen in the photograph (Fig. 7).

Configurations designated $WBNG_pPS$ have nine pylons loaded with stores with the unloaded pylon being the test position for the captive store. The launch or unloaded pylon is designated with a subscript such as P_1, P_3, or P_4 for launching from pylons 1, 3, or 4, respectively. In the loaded configuration, pylons 1 and 11 carry one MK-82 bomb each, pylons 2 and 10 carry one BLU-27 firebomb each, pylons 3 and 9 carry a Triple Ejection Rack (TER) with two BLU-27 bombs at the shoulder positions, pylons 4 and 8 carry a TER with three MK-82 bombs, and pylons 5 and 7 carry a Multiple Ejection Rack (MER) with six MK-82 bombs. Figure 4 shows the model in the loaded configuration $WBNG_pP_4S$ with the launch station at pylon 4. The MK-82SE dummy models were used interchangeably.

Dimensional sketches of the MER and TER are shown in Figs. 8 and 9, respectively. Dimensional sketches of the 450-gal fuel tank, BLU-27 finned bomb, and MK-82GP bomb are shown in Figs. 10, 11, and 12, respectively. In the carriage position, the BLU-27

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[1] Test Facilities Handbook (Ninth Edition). "Propulsion Wind Tunnel Facility, Vol. 4." Arnold Engineering Development Center, July 1971.

and MK-82GP bombs have an "X" fin orientation. The fin orientation of the 450-gal fuel tank at launch produces a positive dihedral.

2.3 INSTRUMENTATION

Three-quarter-in. six-component, 0.40-in. six-component, and 0.16-in five-component internal strain-gage balances were used to obtain force and moment data on the 450-gal fuel tank, BLU-27, and MK-82GP models, respectively. The balances were mounted on a 3-in.-offset sting which was in turn mounted from the CTS (Figs. 2 and 4). Translational and angular positions of the store model were obtained from the CTS analog outputs. A digital readout from the main pitch sector was used for setting angle of attack for the parent aircraft. The pylons were instrumented with touch wires which aided in positioning the store model for launch. The system was also electrically connected to automatically stop the CTS and main pitch sector movement if the store model or sting support contacted the aircraft model surface.

SECTION III
TEST DESCRIPTION

3.1 TEST CONDITIONS

Separation trajectory data were obtained at Mach numbers of 0.35 and 0.60. Tunnel dynamic pressure ranged from 275 psf at $M_\infty = 0.35$ to 620 psf at $M_\infty = 0.60$, and tunnel stagnation temperature was maintained near 110°F.

Tunnel conditions were held constant at the desired Mach number and stagnation pressure while data for each trajectory were obtained. The trajectories were terminated when the store or sting contacted the parent-aircraft model or when a CTS limit was reached.

3.2 TRAJECTORY DATA ACQUISITION

To obtain a trajectory, test conditions were established in the tunnel and the parent model was positioned at the desired angle of attack. After the store was set at the desired initial position, operational control of the CTS was switched to the digital computer which controlled the store movement during the trajectory through commands to the CTS analog system (see block diagram, Fig. 1). Data from the wind tunnel, consisting of measured model forces and moments, wind tunnel operating conditions, and CTS rig positions, were input to the digital computer for use in the full-scale trajectory calculations.

The digital computer was programmed to solve the six-degree-of-freedom equations to calculate the angular and linear displacements of the store relative to the parent aircraft pylon. In general, the program involves using the last two successive measured values of each static aerodynamic coefficient to predict the magnitude of the coefficients over the next time interval of the trajectory. These predicted values are used to calculate the new position and attitude of the store at the end of the time interval. The CTS is then commanded to move the store model to this new position and the aerodynamic loads are measured. If these new measurements agree with the predicted values, the process is continued over another time interval of the same magnitude. If the measured and predicted values do not agree within the desired precision, the calculation is redone over a time interval one-half the previous value. This process is repeated until a complete trajectory has been obtained.

In applying the wind tunnel data to the calculations of the full-scale store trajectories, the measured forces and moments are reduced to coefficient form and then applied with proper full-scale store dimensions and flight dynamic pressure. Dynamic pressure was calculated using a flight velocity equal to the free-stream velocity component plus the components of store velocity relative to the aircraft, and a density corresponding to the simulated altitude.

All trajectories initiated at the carriage position were attempted without the use of ejector forces. Each trajectory began at the end of the 4.5-in. ejector stroke utilized calculated store motions as initial inputs for the calculation.

Full-scale store parameters used in the trajectory calculations are listed in Appendix II.

Pitch and yaw aerodynamic damping derivatives used in the equations of motion were determined analytically. Since the force balance used with the MK-82 model did not incorporate an axial-force measurement, an estimate was made of the axial-force coefficient for this shape based on experimental data in the published literature. This value is shown in Appendix II and was input as a constant in the trajectory calculations.

While aerodynamic loads data were being obtained, preselected positions of the store model were programmed in the computer. Figure 13 gives the X/C and Z/C positions at which loads data were obtained beneath each test pylon. All translations were made in the X-Z plane.

3.3 CORRECTIONS

Balance, sting, and support deflections caused by the aerodynamic loads on the store models were accounted for in the data reduction program to calculate the true store-model angles. Corrections were also made for model weight tares to calculate the net aerodynamic forces on the store model.

3.4 PRECISION OF DATA

The trajectory data are subject to error from several sources including tunnel conditions, balance measurements, extrapolation tolerances allowed in the predicted coefficients, computer inputs, and CTS positioning control. Maximum error in the CTS position control was ±0.05 in. for the translational settings and ±0.15 deg for angular displacement settings in pitch and yaw. Extrapolation tolerances were ±0.10 for each of the aerodynamic coefficients. The maximum uncertainties in the full-scale position data caused by the balance inaccuracies are given below. The uncertainties in the measured force and moment coefficients based on these inaccuracies are also given below. The estimated uncertainty in setting Mach number was no greater than ±0.003, and the uncertainty in parent-model angle of attack was estimated to be ±0.1 deg.

Model	t, sec	ΔX, ft	ΔY, ft	ΔZ, ft	Δθ, deg	Δψ, deg
MK-82GP	0.3	—	±0.06	±0.07	±0.3	±0.3
BLU-27	0.3	±0.02	±0.01	±0.01	±0.1	±0.2
450-TK	0.3	±0.3	±0.3	±0.3	±0.7	±0.7

Model	ΔC_N	ΔC_Y	ΔC_A	ΔC_ℓ	ΔC_m	ΔC_n
MK-82GP	0.01	0.01	—	0.02	0.001	0.002
BLU-27	0.005	0.008	0.01	0.002	0.001	0.01
450-TK	0.02	0.02	0.02	0.005	0.002	0.02

SECTION IV
DATA PRESENTATION

The large volume of trajectory and aerodynamic loads data obtained during this test precludes making any significant analysis of test results at this time. Consequently, this report contains only a description of the test and serves as a key to the data. A summary of data index numbers as a function of store configuration, store position, and test condition is presented in Appendix III.

The tabulated data format used in trajectory testing presents store motions and velocities as a function of time from store release while maintaining a given set of test conditions. The aerodynamic loads data present aerodynamic coefficients at each test station in the survey.

APPENDIXES

I. ILLUSTRATIONS
II. FULL-SCALE STORE PARAMETERS USED IN TRAJECTORY CALCULATIONS
III. LISTING OF PART NUMBERS FOR TABULATED TEST DATA

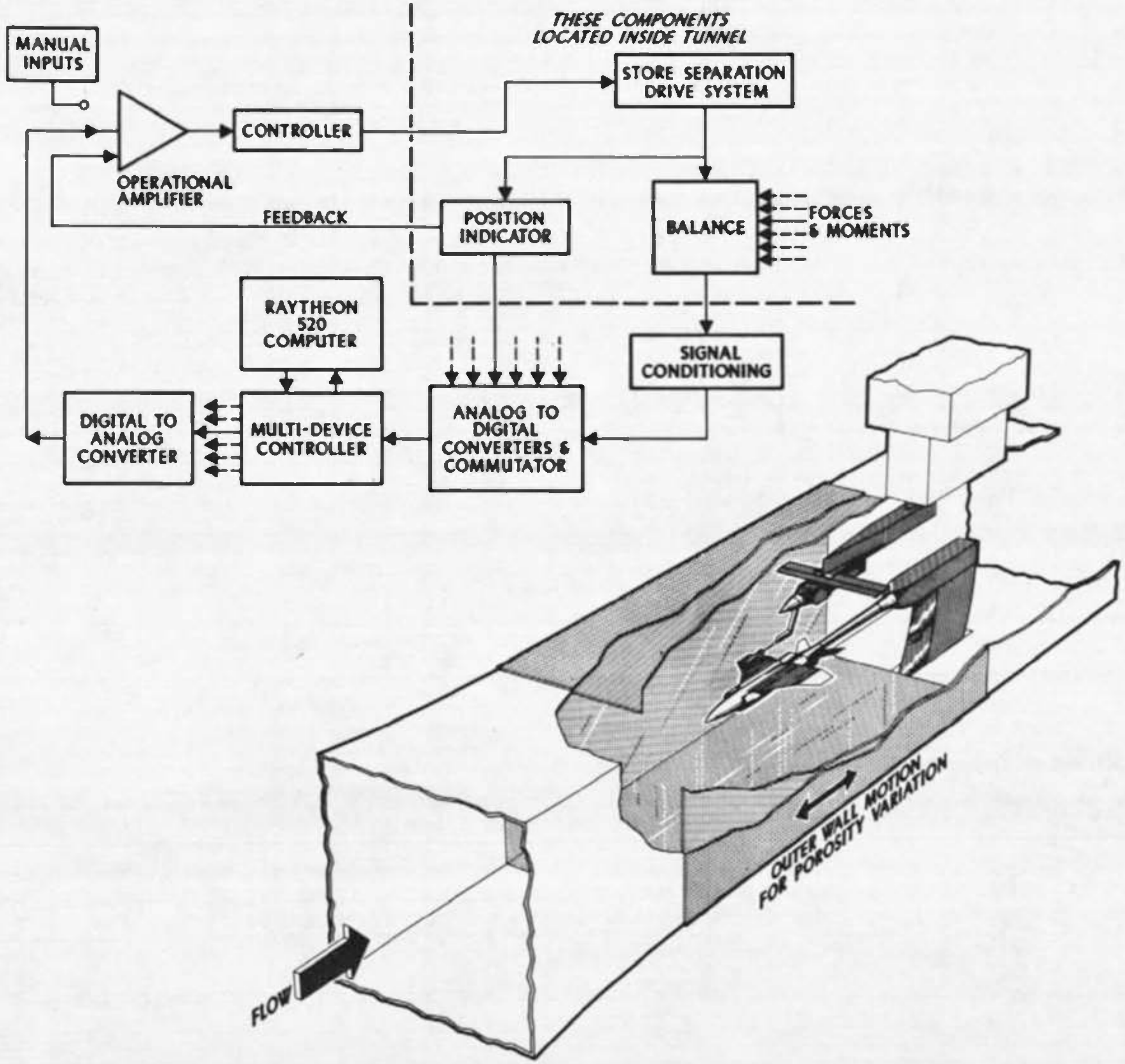


Fig. 1 Isometric Drawing of a Typical Store Separation Installation and a Block Diagram of the Computer Control Loop

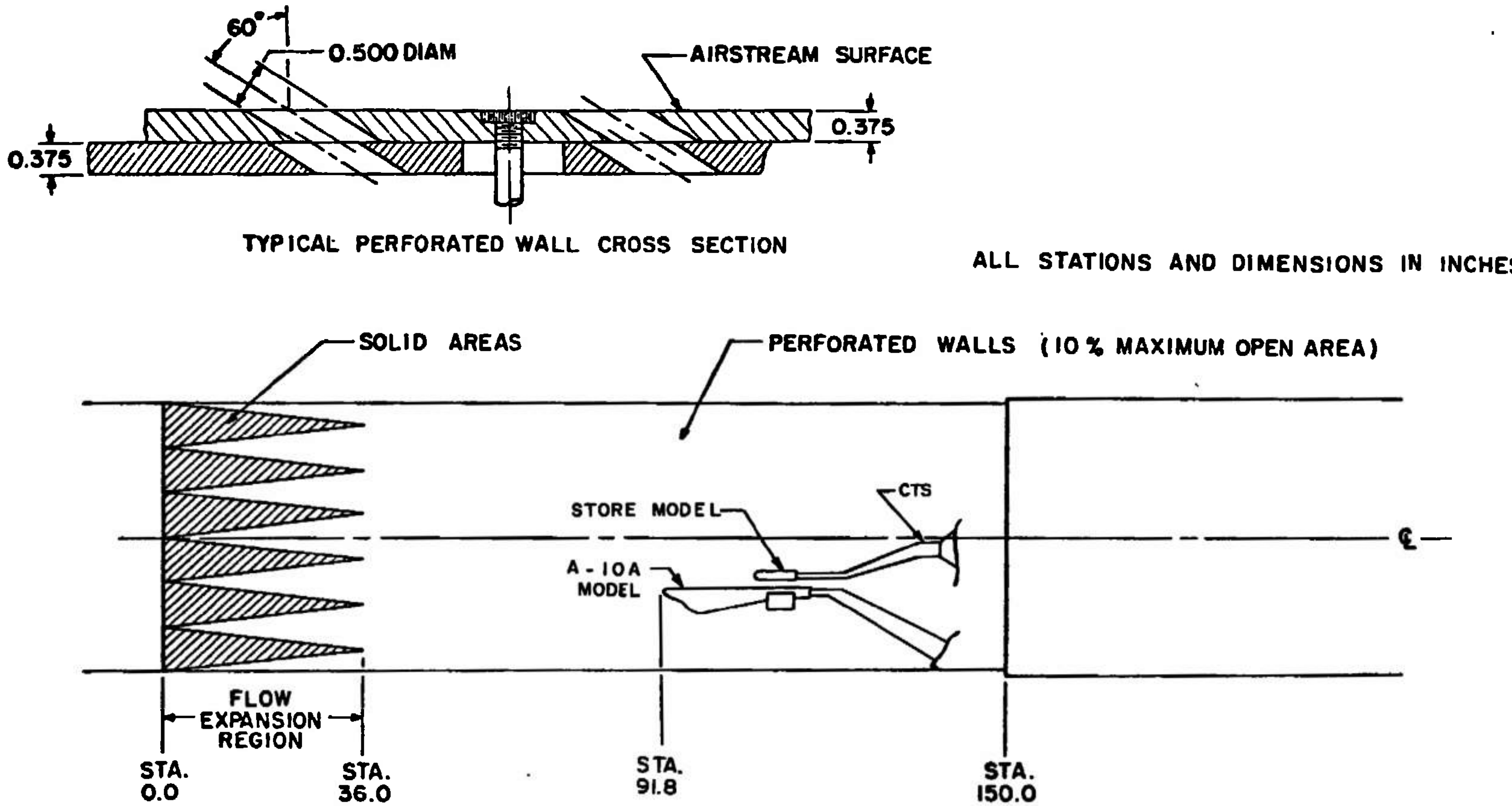


Fig. 2 Schematic of the Tunnel Test Section Showing Model Location

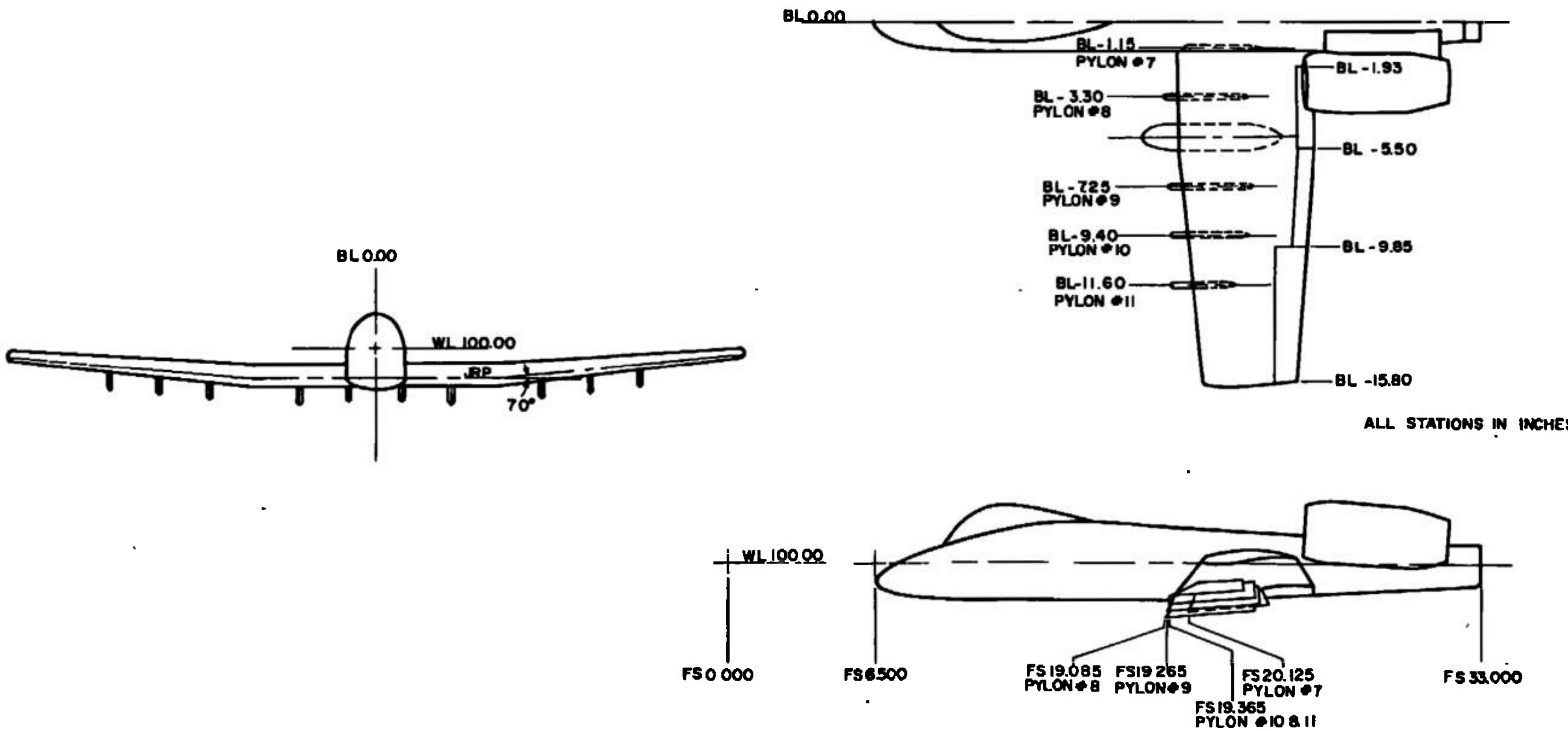


Fig. 3 Sketch of the A-10A Parent Aircraft Model

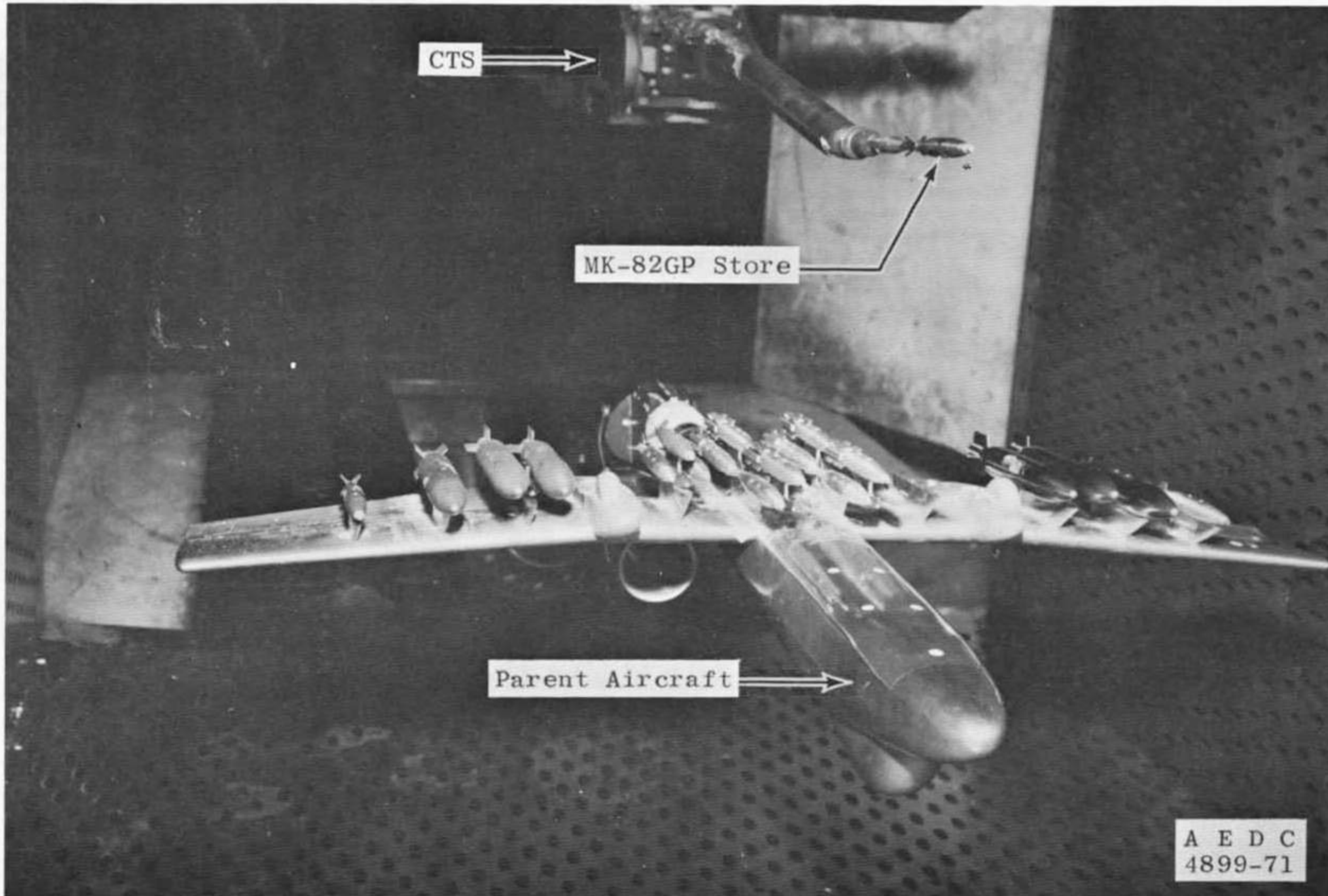


Fig. 4 Tunnel Installation Photograph Showing Parent Aircraft, Stores, and CTS

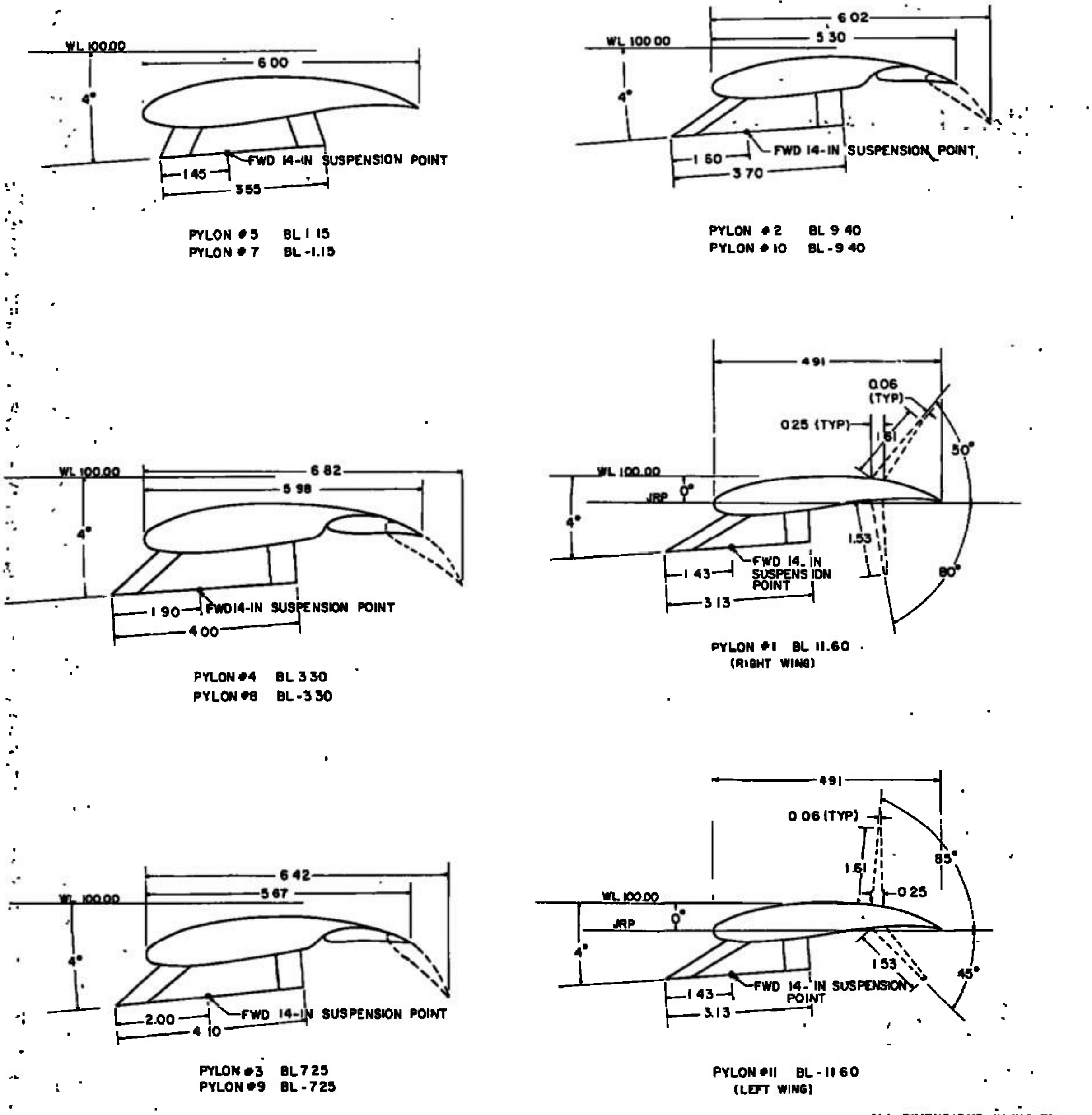


Fig. 5 Dimensional Sketch of the A-10A Wing Pylons

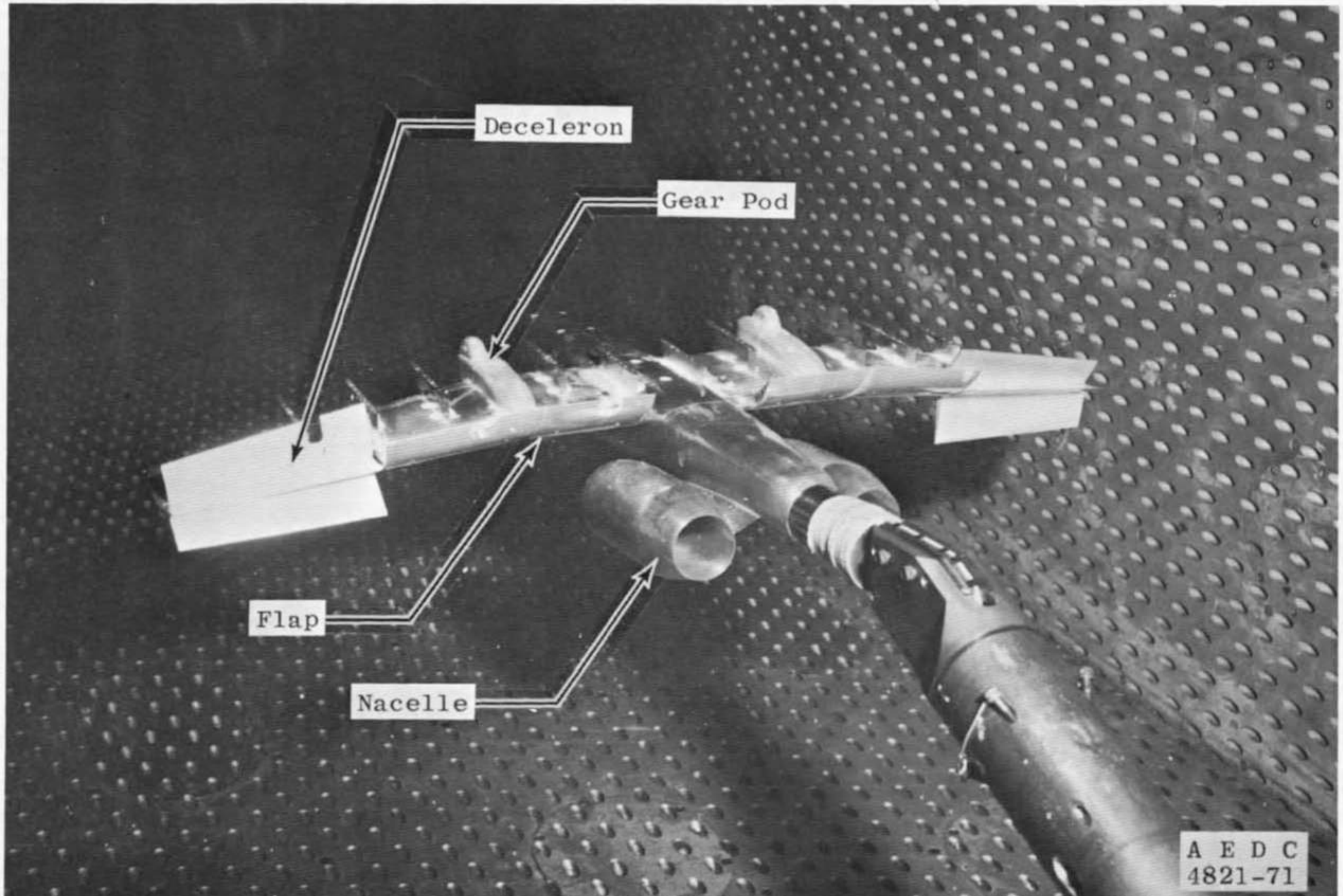


Fig. 6 A-10A Parent Aircraft Model with Control Surfaces Deflected, Configuration $WBNG_pPC$

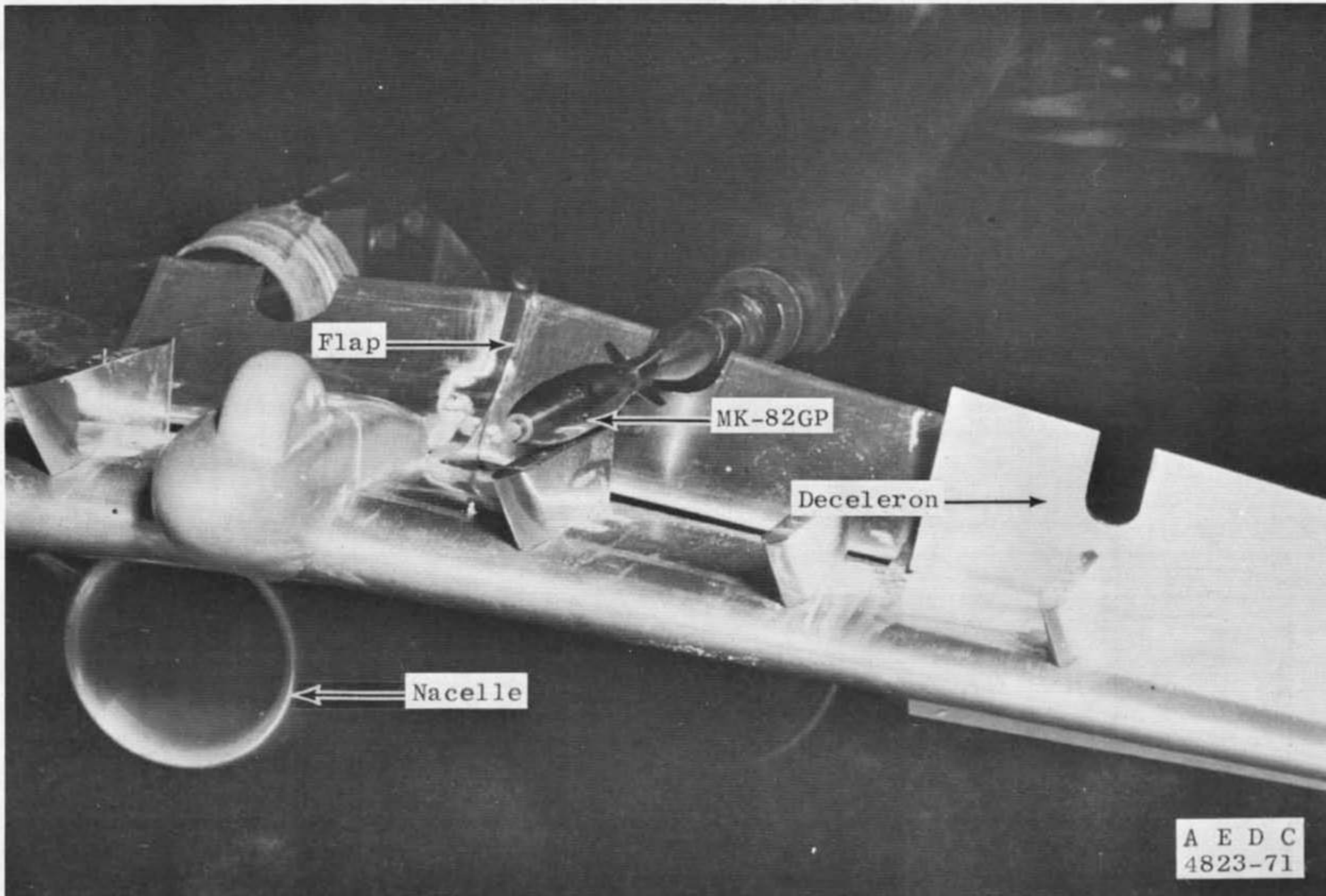


Fig. 7 A-10A Parent Aircraft Model Showing Flap and Deceleron Modifications

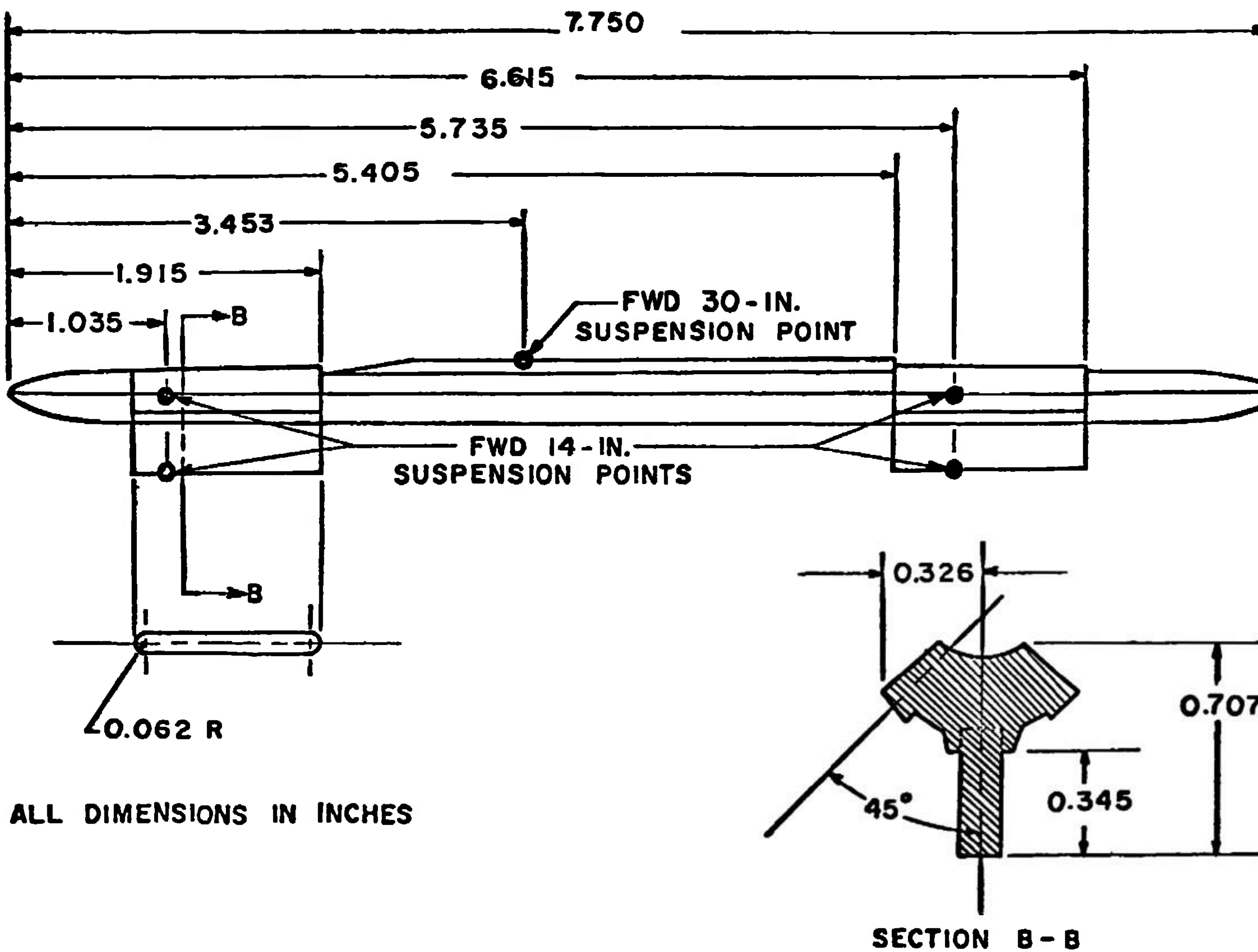


Fig. 8 Details and Dimensions of the MER Model

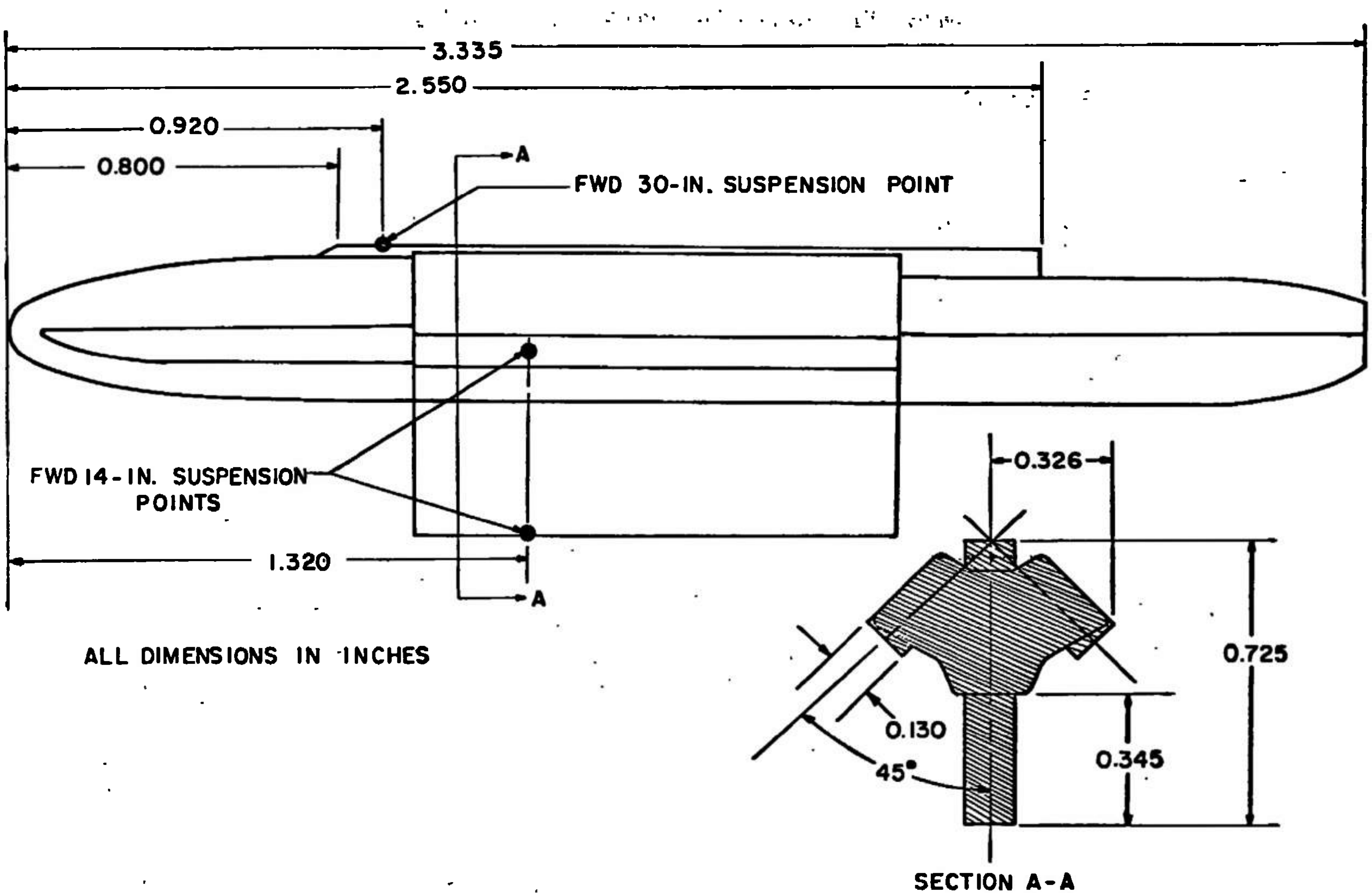


Fig. 9 Details and Dimensions of the TER Model

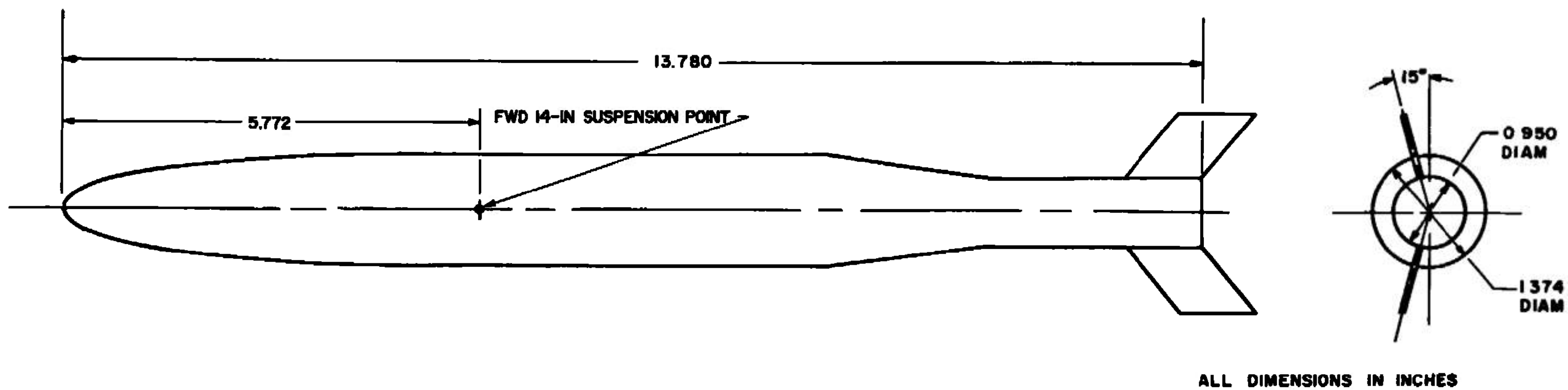


Fig. 10 Details and Dimensions of the 450-gal Fuel Tank Model

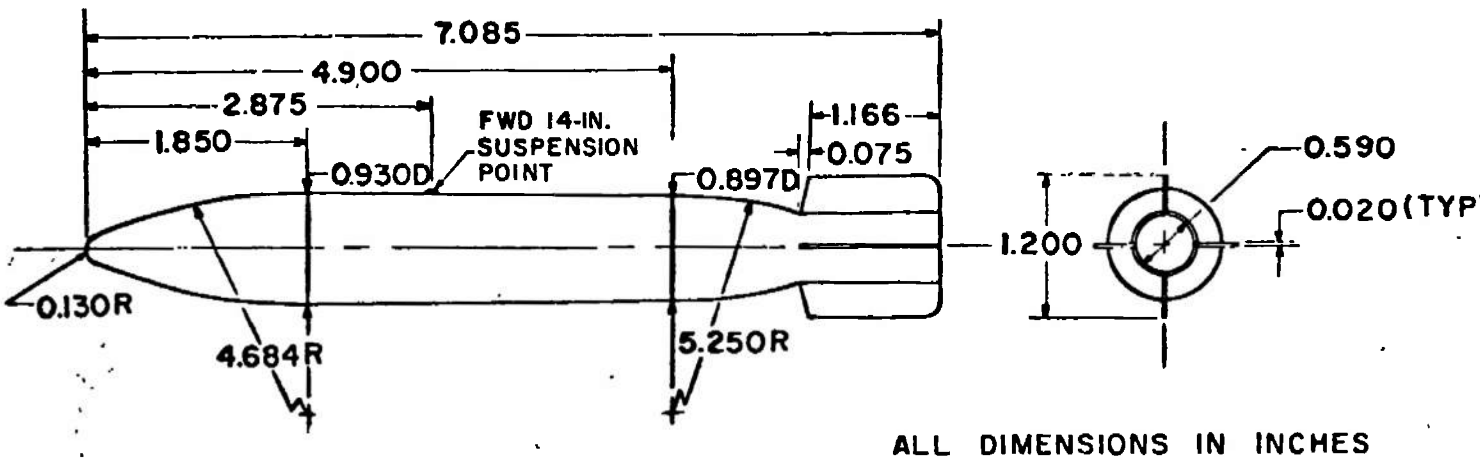


Fig. 11 Details and Dimensions of the BLU-27 Model

STA.	DIAM
0.000	0.150
0.210	0.150
0.212	0.231
0.312	0.282
0.412	0.322
0.512	0.361
0.612	0.391
0.712	0.421
0.812	0.445
0.912	0.465
1.012	0.483
1.112	0.497
1.212	0.510
1.312	0.520
1.412	0.525
1.512	0.530
1.612	0.532
1.712	0.533
1.812	0.535
1.912	0.537
2.312	0.537
2.412	0.535
2.512	0.525
2.612	0.520
2.712	0.510
2.812	0.497
2.912	0.483
3.012	0.465
3.173	0.438

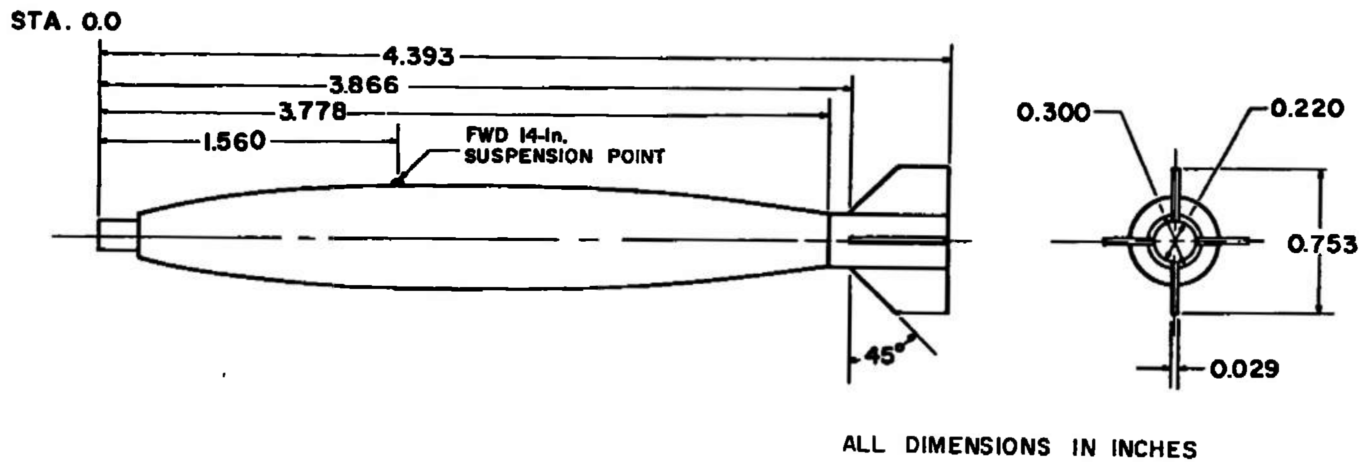
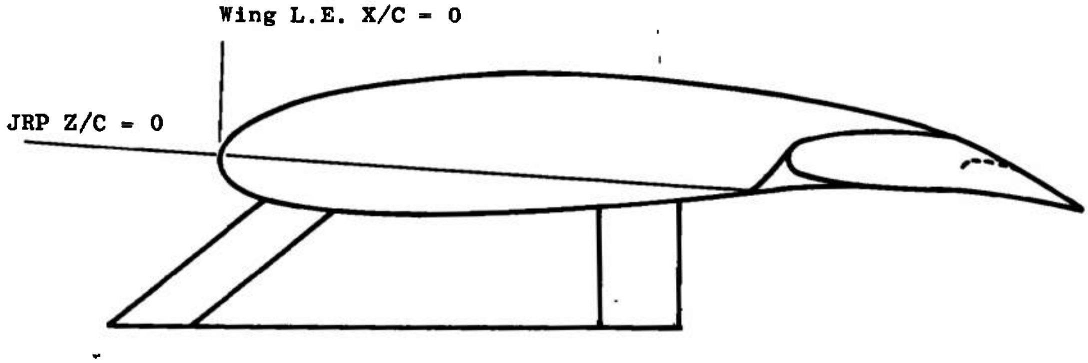


Fig. 12 Details and Dimensions of the MK-82GP Model



Longitudinal Distance
Aft of Wing L.E., X/C

Vertical Distance below JRP	-0.2		0		0.2		0.4		0.6		0.8		1.0		1.2
0.3															
		x	x	x	x		x								x
0.4		x		x							x				
0.5			x		x		x				x				
0.6															
0.7			x		x		x				x				x
0.8															
0.9		x		x			x				x				
1.0															
1.1															
1.2		x			x						x				

Fig. 13 Locations Corresponding to Aerodynamic Loads Data Acquisition

APPENDIX II
FULL-SCALE STORE PARAMETERS USED IN TRAJECTORY CALCULATIONS

Parameter	MK-82	BLU-27	450-TK Full	450-TK Empty
C_{m_q}, per rad.	-0.76	-0.81	-0.50	-0.50
C_{n_r}, per rad.	-53.00	-48.00	-50.00	-50.00
$C_{\ell p}$, per rad.	-0.015	-2.000	-0.010	-0.010
C_A	0.2	---	---	---
$\bar{m}$, slugs	16.380	25.495	97.170	6.219
X_{cg}, ft	3.183	5.467	11.258	11.258
b, ft	0.896	1.542	2.29	2.29
$\bar{c}$, ft	7.467	11.808	22.75	22.75
S, ft^2	0.630	1.866	3.98	3.98
I_{xx}, slug-ft^2	1.3	11.6	81.95	8.919
I_{yy}, slug-ft^2	29.6	161.5	4376.4	281.93
I_{zz}, slug-ft^2	29.6	164.5	4376.4	281.93

APPENDIX III
LISTING OF PART NUMBERS FOR TABULATED TEST DATA

TRAJECTORY DATA										
Parent Configuration	Z_i, ft	Store Tested	$\overline{\theta}$, deg	w_i, ft/sec	q_i, radians/sec	Data Index Number				
						M_∞ = 0.35			M_∞ = 0.60	
						α = -4 deg	α = 0	α = 5 deg	α = -4 deg	α = 0
$WBNG_pP_4$	0	MK-82	0	0	0	68	48	83	97	107
	0.375			3			49			
				10	0.5		50		98	
					0.2	69	51	84		
					0	72	52		99	108
					-0.2	73	53	85	100	109
					-0.5		54		101	
	0		-15	0	0	74	55	86	102	110
	0.375			10	0.2	75	56	87		
	0.375			10	0		57			
	0.375			10	-0.2	76	58	88	103	111
	0		-30	0	0	77	59	89	104	112
	0.375			10	0.2	78	60	90	105	113
	0.375			10	0		61			
	0.375			10	-0.2	79	64	91	106	114
	0		-60	0	0	80	63	92		
	0.375			10	0.5	81	65	93		
					0.2					
					0		66	94		
					-0.2					
					-0.5	82	67	95		
$WBNG_pP_1$	0		0	0	0	31				
	0.375			3						
	0.375			10	0.5					
	0.375			10	0.2	32				

APPENDIX III (Continued)

Parent Configuration	Z_i, ft	Store Tested	$\overline{\theta}$, deg	w_i, ft/sec	q_i, radians/sec	Data Index Number				
						M_∞ = 0.35			M_∞ = 0.60	
						α = -4 deg	α = 0	α = 5 deg	α = -4 deg	α = 0
$WBNG_pP_1$	0.375	MK-82	0	10	0	33				
	0.375		0	10	-0.2	34				
	0.375		0	10	-0.5					
	0		-15	0	0	36				
	0.375			10	0.2					
				10	0					
				10	-0.2	37				
	0		-30	0	0	38				
	0.375			10	0.2					
	0.375			10	0	41				
	0.375			10	-0.2	42				
	0		-60	0	0	43				
	0.375			10	0.5					
					0.2					
					0	44				
					-0.2	47				
					-0.5					
$WBNG_pP_1C$	0		0	0	0	139				
	0.375			10	0.2	140				
	0.375			10	0	141	154			
	0.375			10	-0.2	142				
	0		-15	0	0	143				
	0.375		-15	10	0	144				
	0.375		-15	10	-0.2	145				
	0		-30	0	0	146				

APPENDIX III (Continued)

Parent Configuration	Z_i, ft	Store Tested	$\overline{\theta}$, deg	w_i, ft/sec	q_i, radians/sec	Data Index Number				
						M_∞ = 0.35			M_∞ = 0.60	
						α = -4 deg	α = 0	α = 5 deg	α = -4 deg	α = 0
$WBNG_pP_1C$	0.375	MK-82	-30	10	0	147				
	0.375		-30	10	-0.2	148				
	0		-60	0	0	149				
	0.375		-60	10	0	152				
	0.375		-60	10	-0.2	153				
$WBNG_pP_4C$	0		0	0	0	157	172		155	
	0.375			10	0.2	158			156	
	0.375			10	0	159	173			
	0.375			10	-0.2	160	174			
	0		-15	0	0	161	175			
	0.375		-15	10	0	162				
	0.375		-15	10	-0.2	163	176			
	0		-30	0	0	164	177			
	0.375			10	0.2	165	178			
	0.375			10	0	166				
	0.375			10	-0.2	167	179			
	0		-60	0	0	168	180			
	0.375			10	0.5	169				
	0.375			10	0	170	181			
	0.375			10		171	182			
$WBNG_pP_4S$	0		0	0	0	210	193		220	
	0.375			10	0.2		194			
					0	211	195		230	
					-0.2	212	196		231	
					-0.5				232	

APPENDIX III (Continued)

Parent Configuration	Z_i, ft	Store Tested	$\overline{\theta}$, deg	w_i, ft/sec	q_i, radians/sec	Data Index Number				
						M_∞ = 0.35			M_∞ = 0.60	
						α = -4 deg	α = 0	α = 5 deg	α = -4 deg	α = 0
$WBNG_pP_4S$	0	MK-82	-15	0	0	213	197		233	
	0.375		-15	10	0.2		198			
	0.375		-15	10	-0.2	214	199		235	
	0		-30	0	0	215	202		236	
	0.375		-30	10	0.2		203			
	0.375		-30	10	-0.2	216	204		237	
	0		-60	0	0	217	205			
	0.375		-60	10	0.5	218	208			
	0.375		-60	10	-0.5	219	209			
$WBNG_pP_3S$	0	BLU-27	0	0	0	284	269		294	303
	0.375			10	0.5				295	
					0.2		270			
					0		271		296	304
					-0.2	285	272		297	
					-0.5				298	
	0		-15	0	0	286	273		299	
	0.375		-15	10	0.2		274			
	0.375		-15	10	-0.2	287	275		300	
	0		-30	0	0	288	276		301	
	0.375		-30	10	0.2		277			
	0.375		-30	10	-0.2	289	278		302	
	0		-60	0	0	290	279			
	0.375		-60	10	0.5	291	280			
	0.375		-60	10	-0.5	292	281			
$WBNG_pP_3C$	0		0	0	0	316	329			

APPENDIX III (Continued)

Parent Configuration	Z_i, ft	Store Tested	$\overline{\theta}$, deg	w_i, ft/sec	q_i, radians/sec	Data Index Number				
						M_∞ = 0.35			M_∞ = 0.60	
						α = -4 deg	α = 0	α = 5 deg	α = -4 deg	α = 0
$WBNG_pP_3C$	0.375	BLU-27	0	10	0.2	317				
	0.375		0	10	0	318	330			
	0.375		0	10	-0.2	319	331			
	0		-15	0	0	320	332			
	0.375		-15	10	-0.2	322	333			
	0		-30	0	0	323	335			
	0.375		-30	10	0.2		336			
	0.375		-30	10	0	324				
	0.375		-30	10	-0.2	325	337			
	0		-60	0	0	326	341			
	0.375		-60	10	0	327	339			
	0.375		-60	10	-0.2	328	340			
$WBNG_pP_3$	0		0	0	0	382	359	395	430	439
	0.375			3			361			
				10	0.5		362			
					0.2	383	363	396	422	420
					0	384	364	414	432	441
					-0.2	385	365	397	433	442
					-0.5	416	366	415	434	421
	0		-15	0	0	386	367	398	435	443
	0.375		-15	10	0.2	387	368	399		
	0.375		-15	10	0		369			
	0.375		-15	10	-0.2	388	370	400	436	444
	0		-30	0	0	389	381	401	437	445
	0.375		-30	10	0.2	390	374	402		446

Parent Configuration	Z_i, ft	Store Tested	$\overline{\theta}$, deg	w_i, ft/sec	q_i, radians/sec	Data Index Numbers				
						$M_\infty = 0.35$			$M_\infty = 0.60$	
						α = -4 deg	α = 0	α = 5 deg	α = -4 deg	α = 0
$WBNG_pP_3$	0.375	BLU-27	-30	10	0		373			
	0.375		-30	10	-0.2	391	376	403	438	447
	0		-60	0	0	392	377	404	423	
	0.375			10	0.5	393	378	405	424	
					0.2	408	412	410	425	
					0		379		426	
					-0.2	409	413	411	427	
					-0.5	394	380	407	428	
$WBNG_pP_4$	0	450-TK. (Full)	0	0	0	494				
	0.375			3		521				
				10	0.5	522	528			
					0.2	495	529	533		
					0	496	500			
					-0.2	497	501			
					-0.5	525	530			
	0		-15	0	0	498	502			
	0.375		-15	10	0.2	526	531			
	0.375		-15	10	0	527	532	534		
	0.375		-15	10	-0.2	499	503			
	0	450-TK. (Empty)	0	0	0	504				
	0.375			10	0.2	505		537		
	0.375			10	0	506	510	538		
	0.375			10	-0.2	507	511	539		
	0		-15	0	0	508	512			
	0.375		-15	10	0	535	536	540		
	0.375		-15	10	-0.2	509	513			

APPENDIX III (Continued)

AERODYNAMIC LOADS DATA

Parent Configuration	Store Tested	Store Orientation		Data Index Numbers					
				$M_\infty = 0.35$			$M_\infty = 0.60$		
		Pitch	Yaw	α = -4 deg	α = 0	α = 5 deg	α = -4 deg	α = 0	α = 5 deg
$WBNG_pP_4$	MK-82	0	0		15				
		-4	0	17	14	16	18	19	20
		-4	-3		14		18		
		-4	3		14		18		
$WBNG_pP_3$		1	0					27	
		0	0		21				
		-4	0	24	22	23	25	26	28
			-3		22		25		
			3		22		25		
$WBNG_pP_1$			0	12	11	13			
$WBNG_pP_1$			-3		11				
$WBNG_pP_1$			3		11				
$WBNG_pP_4C$			0	132	133	134	135	136	
$WBNG_pP_4C$			-3	137			135		
$WBNG_pP_4C$			3	137			135		
$WBNG_pP_3C$			0	127	128	129	130	131	
$WBNG_pP_3C$			-3	127			130		
$WBNG_pP_3C$			3	127			130		
$WBNG_pP_1C$			0	117	118	119			
$WBNG_pP_1C$			-3	117					
$WBNG_pP_1C$			3	117					
$WBNG_pP_4S$		0	0		188				
		-4	0	190	187	189	191	192	
			-3		187		191		
			3		187		191		
$WBNG_pP_3S$		0	0		240				

APPENDIX III (Continued)

Parent Configuration	Store Tested	Store Orientation		Data Index Numbers					
				M_∞ = 0.35			M_∞ = 0.60		
		Pitch	Yaw	α = -4 deg	α = 0	α = 5 deg	α = -4 deg	α = 0	α = 5 deg
$WBNG_pP_3S$	MK-82	-4	0	247	241	244	252	253	
			-3	247	241		254		
			3	247	241		254		
	BLU-27	0	0	261	257				
		-4	0	265	258	260	262	263	264
			-3		258		262		
			3		258		262		
$WBNG_pP_3C$		0	0	308					
		-4	0	309	310	311	312	313	
			-3	309			312		
			3	309			312		
$WBNG_pP_3$		0	0	450	452	454	462	459	461
			0	451	453	455	458	460	
			-3	451	453	455	458	460	
			3	451	453	455	458	460	
		0	0		345	347	354		
		-4	0	358	346	347	355	356	357
		-4	-3		346		355		
		-4	3		346		355		
$WBNG_pP_4$	450-TK	0	0		487		490		
		-4	0	482	481	483	492	493	491
			-3		481		492		
$WBNG_pP_3$			3		481		492		
			0	485	484	486			
			-3		484				
			3		484				

APPENDIX III (Concluded)

Store Free-Stream Data			
Store Tested	Data Index Number		
	Mach Number		
	0.35	0.50	0.60
MK-82	3	4	5
BLU-27	465	467	468
450-TK	474	475	476

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Arnold Engineering Development Center Arnold Air Force Station, Tennessee 37389	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP N/A

3. REPORT TITLE
SEPARATION CHARACTERISTICS AND AERODYNAMIC LOADS DATA FOR THE MK-82GP, BLU-27, AND 450-GAL FUEL TANK IN THE VICINITY OF THE A-10A AIRCRAFT AT SUBSONIC SPEEDS

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Final Report, June 15 through 22, 1971

5. AUTHOR(S) (First name, middle initial, last name)
R. W. Butler, ARO, Inc.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
October 1971	39	1

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S) AEDC-TR-71-207
b. PROJECT NO	
c. Program Element 64211	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d. Task 02B	ARO-PWT-TR-71-152

10. DISTRIBUTION STATEMENT Distribution limited to U.S. Government agencies only; this report contains information on test and evaluation of military hardware; October 1971; other requests for this document must be referred to Aeronautical Systems Division (SDXT), Wright-Patterson AFB, OH 45433.

11. SUPPLEMENTARY NOTES Available in DDC.	12. SPONSORING MILITARY ACTIVITY Aeronautical Systems Division (SDXT), Wright-Patterson AFB, OH 45433

13. ABSTRACT

Tests were conducted in the Aerodynamic Wind Tunnel (4T) to obtain store separation data and aerodynamic loads data on the MK-82GP, BLU-27, and 450-gal fuel tank in the flow field of the A-10A aircraft. Data were obtained at Mach numbers of 0.35 and 0.60 at a simulated altitude of 5000 ft. Free-stream force and moment data were also obtained for each store at Mach numbers of 0.35, 0.50, and 0.60. This report contains a description of the test and the recorded data, and presents an index of data obtained.

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DD FORM 1 NOV 65 1473

UNCLASSIFIED

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
A-10A aircraft						
jet aircraft						
external stores						
subsonic flow						
aerodynamic loads						

AFSC
Arnold AFS Tenn